US 20070051633A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2007/0051633 A1
Meyer et al. (43) Pub. Date: Mar. 8, 2007

(54) SYSTEM AND METHOD OF HYDROGEN AND OXYGEN PRODUCTION

(76) Inventors: Michael S. Meyer, Louisville, KY (US); Ryan L. Todd, Sonora, KY (US)

Correspondence Address:
MIDDLETON & REUTLINGER
2500 BROWN & WILLIAMSON TOWER
LOUISVILLE, KY 40202

(21) Appl. No.: 11/468,574

(22) Filed: Aug. 30, 2006

Related U.S. Application Data

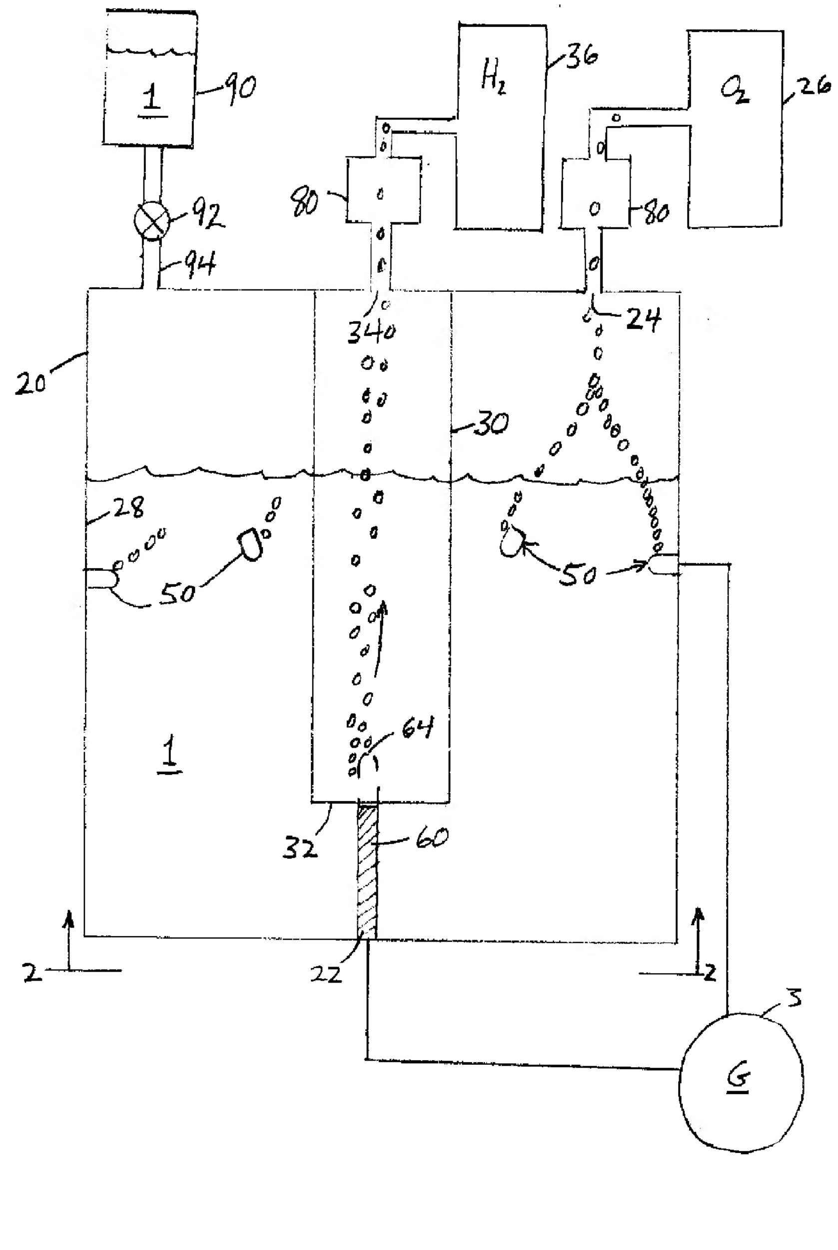
(60) Provisional application No. 60/712,627, filed on Aug. 30, 2005.

Publication Classification

(51) Int. Cl.
C25B 1/02 (2006.01)
(52) U.S. Cl. 205/108; 205/628; 205/637

(57) ABSTRACT

The invention is an apparatus and method for producing hydrogen and oxygen gas from an aqueous liquid utilizing a direct current power source. The apparatus utilizes an outer reaction chamber having a plurality of cathodes therein and an inner reaction chamber having an anode disposed therein. A direct current power source capable of supplying a pulsed output waveform is connected between the plurality of cathodes and the anode, thereby initiating a electrolytic reaction at the cathodes and anode and further, creating a pyrolitic reaction proximate the anode for enhanced liberation of hydrogen gas.



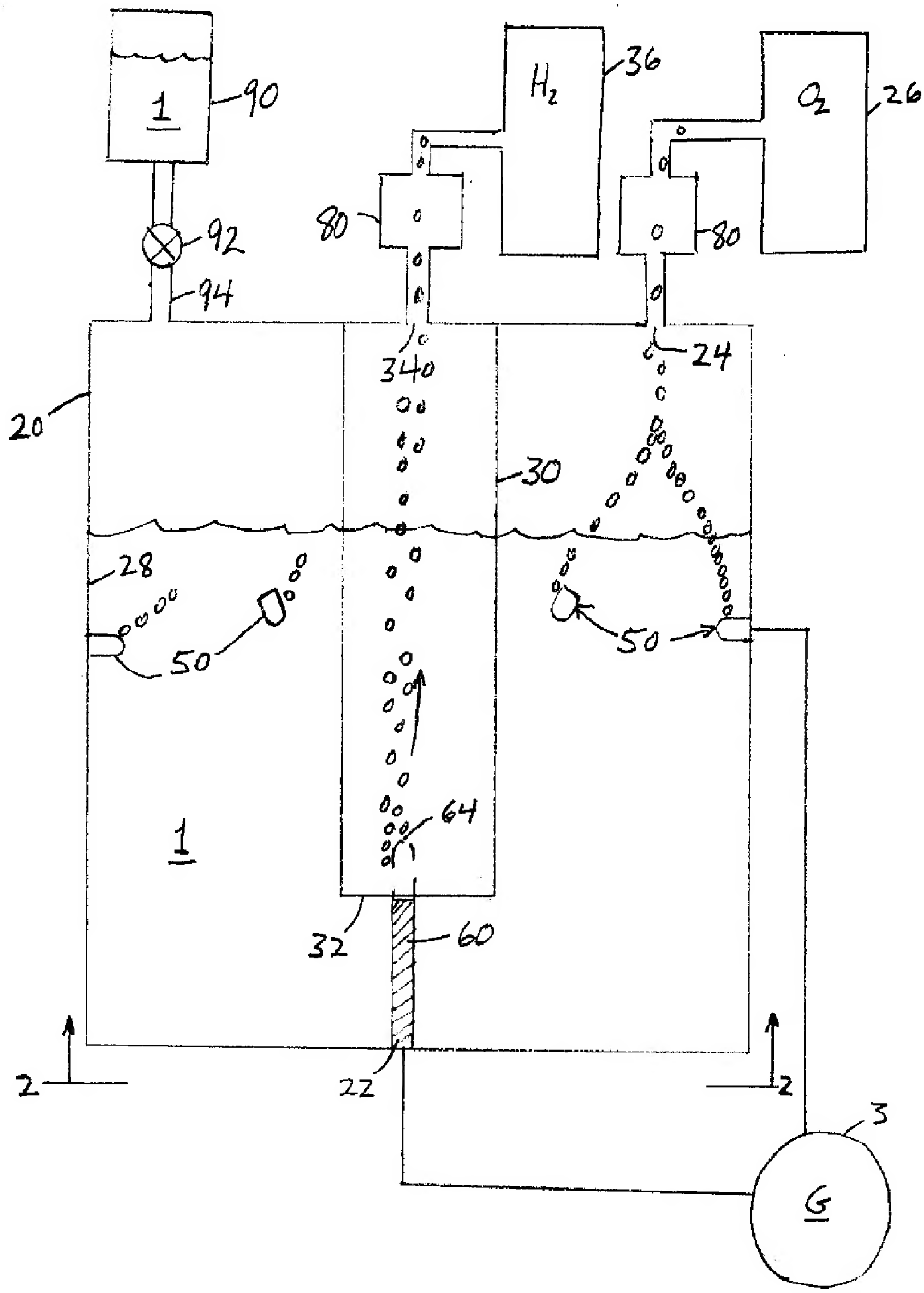


FIG. 1

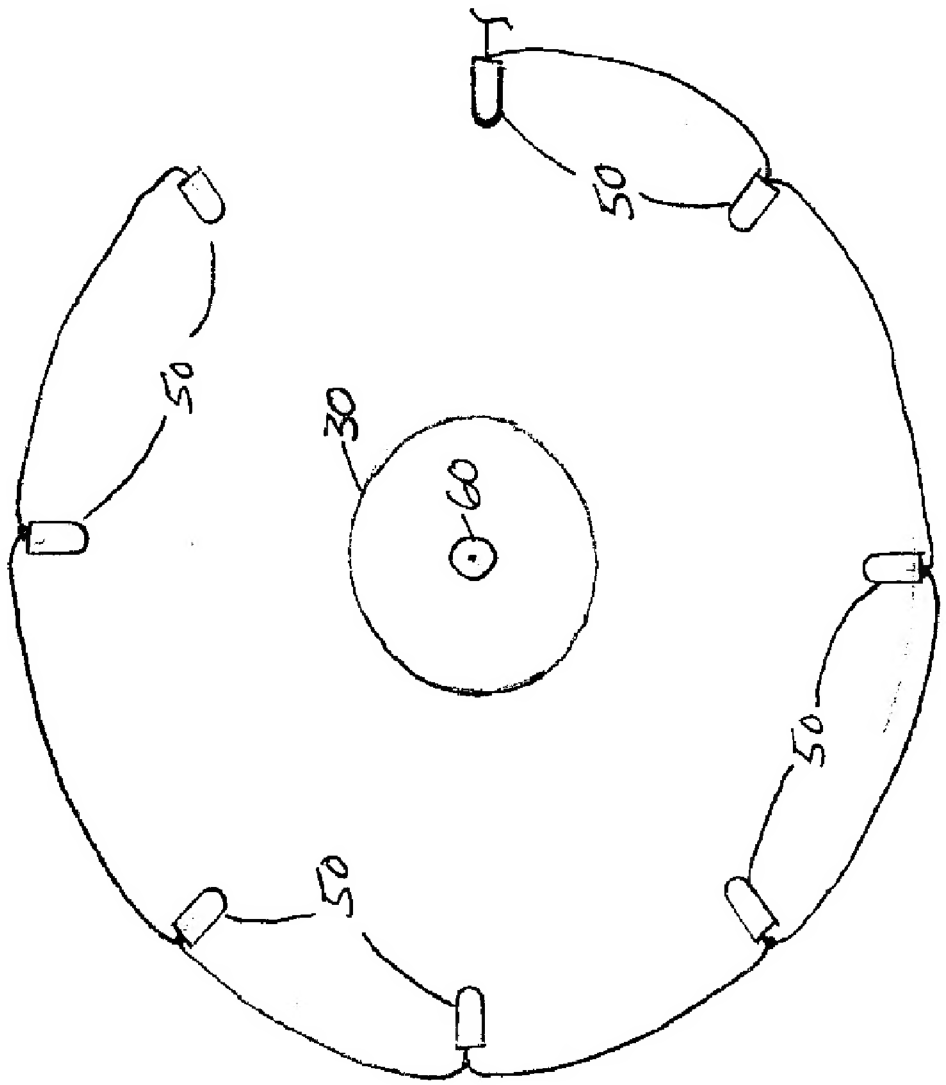


FIG. 2

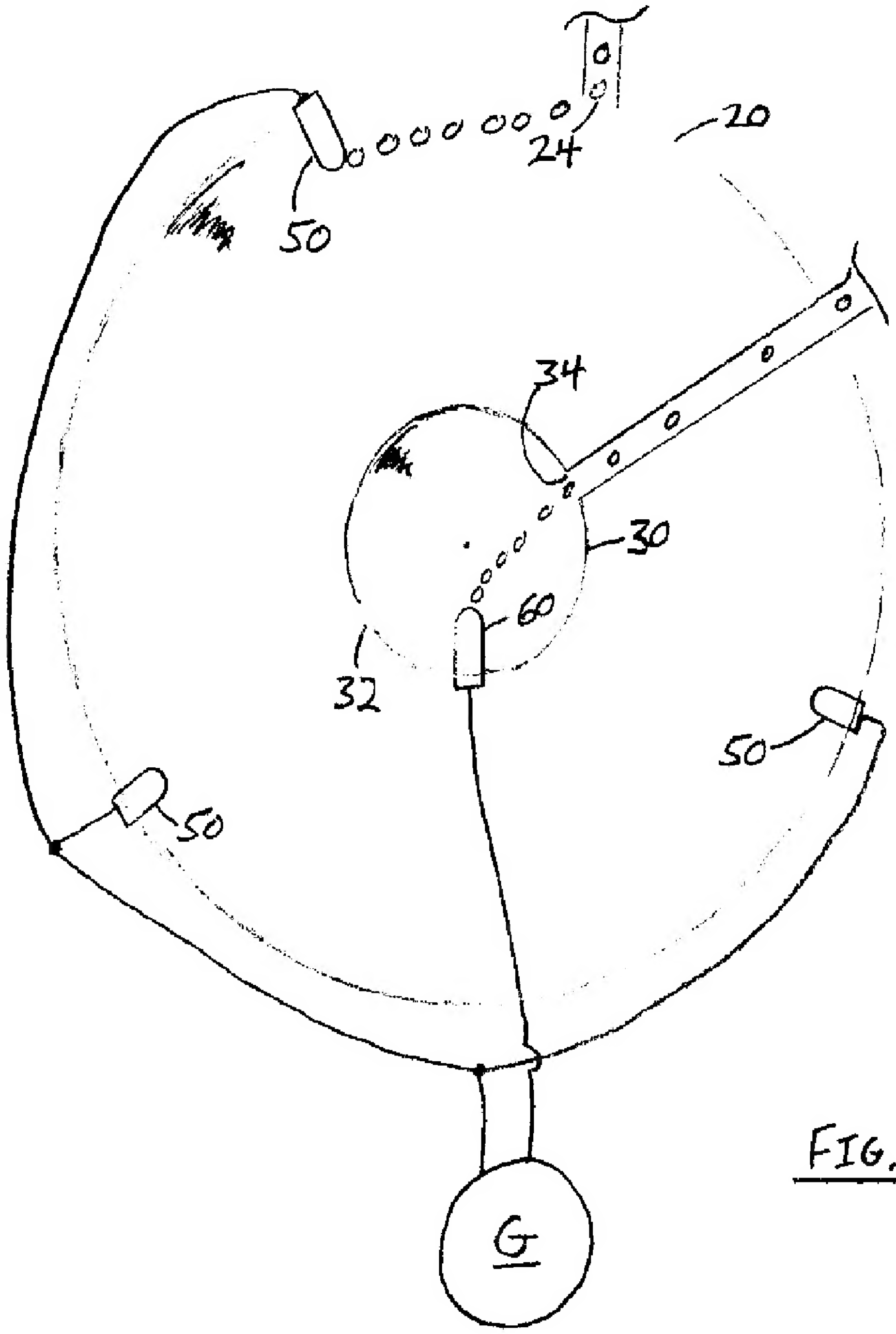


FIG. 3

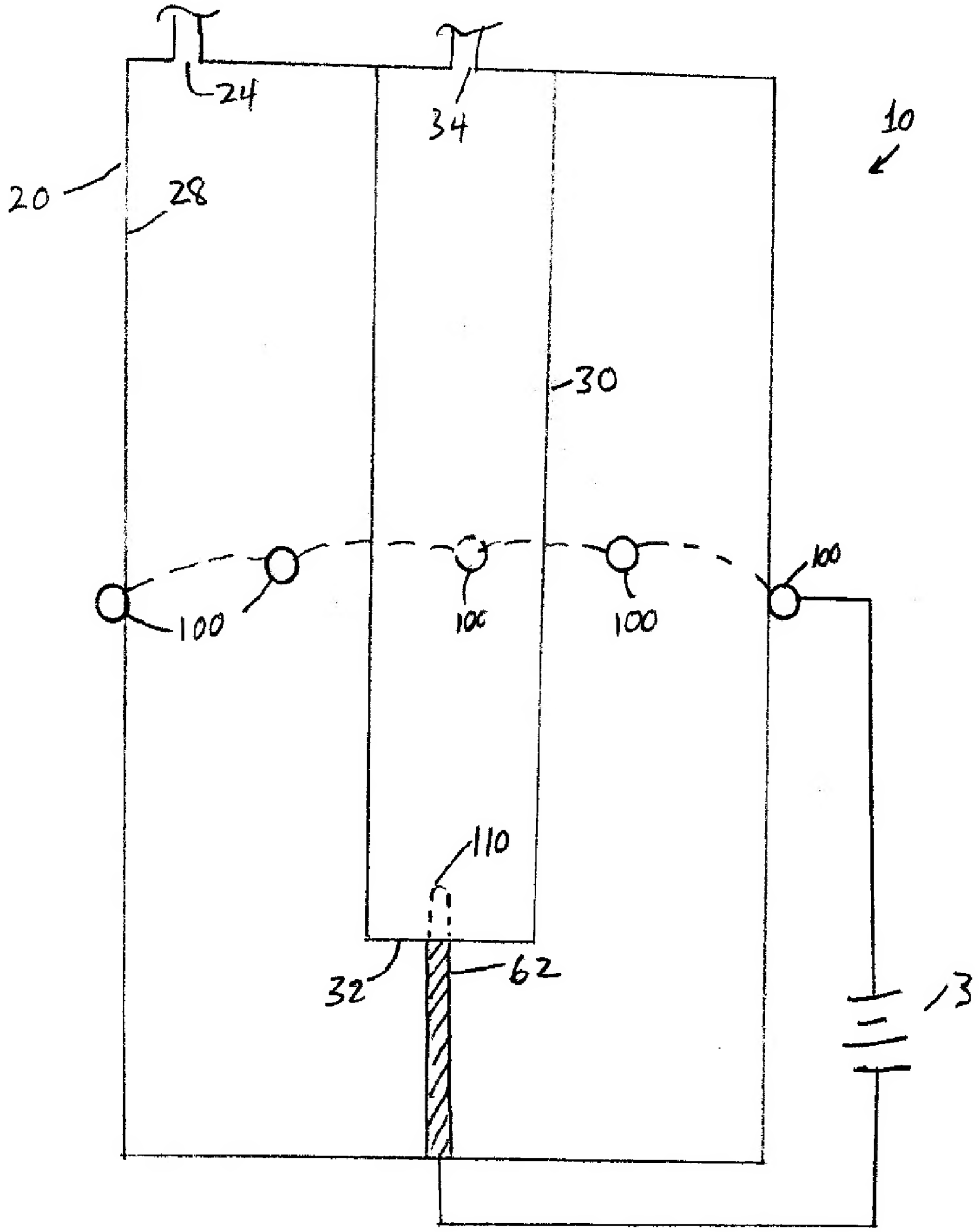


FIG. 4

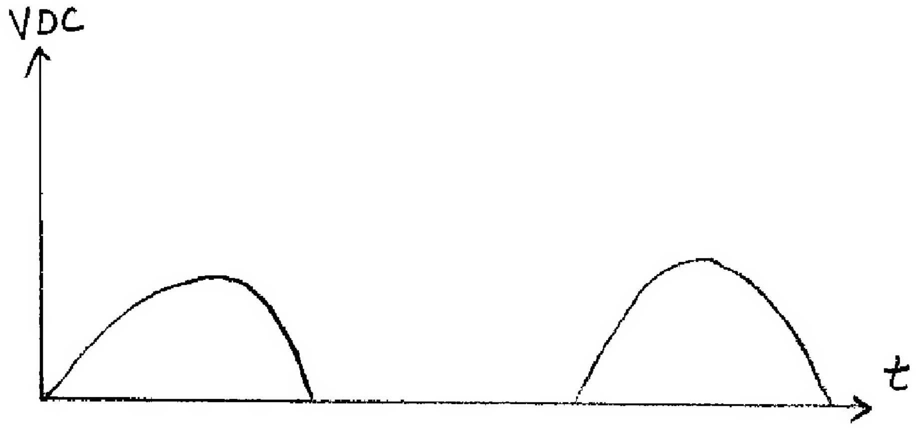


FIG. 5A

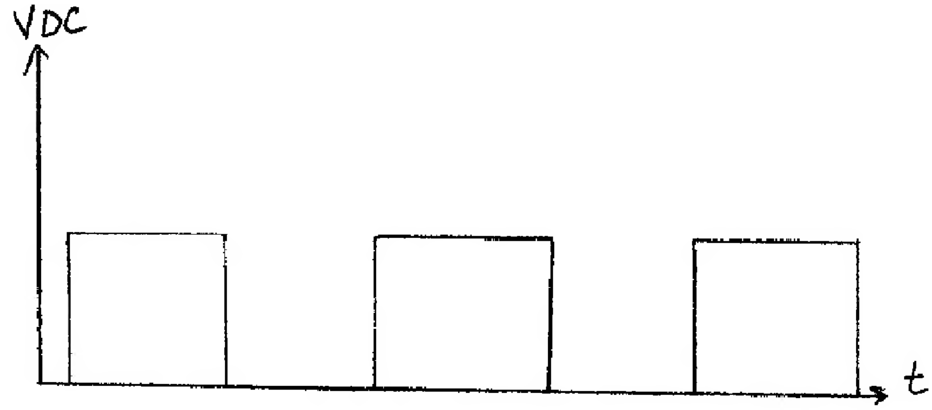


FIG. 5B

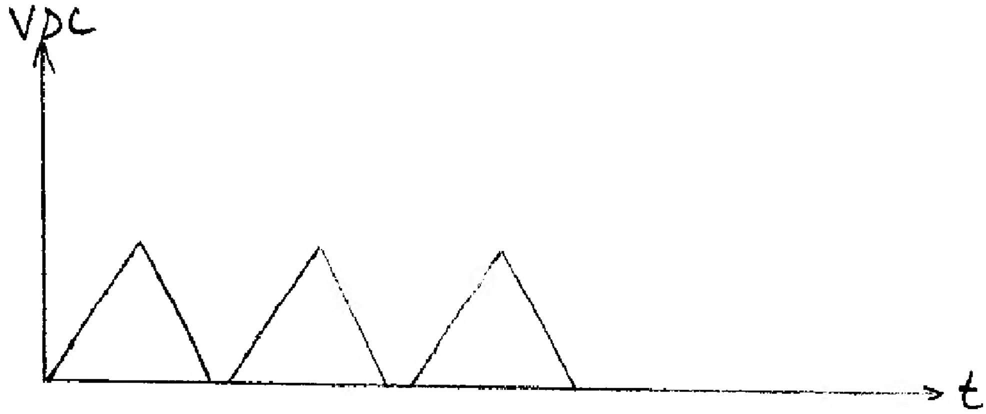


FIG. 5C

SYSTEM AND METHOD OF HYDROGEN AND OXYGEN PRODUCTION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present invention claims the benefit of and priority to co-pending U.S. Provisional Patent Application No. 60,712,627 entitled "System and Method of Hydrogen and Oxygen Production" filed Aug. 30, 2005.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates generally to an apparatus and method for electrolysis of a fluid and more specifically to an apparatus and method for separation of gaseous hydrogen and oxygen from aqueous solutions utilizing a two chamber reaction space and electrolytic action as a separation method and catalyst for pyrolitic separation of the aqueous fluid.

SUMMARY OF THE INVENTION

[0004] In recent years, the advent of fuel cell technology has required the use of hydrogen gas as a fuel source for many advanced fuel cells which has in turn sparked a high demand for hydrogen gas. Unfortunately, prior art systems for the production of hydrogen gas are relatively expensive to operate due to the high energy cost of producing hydrogen gas from known methods. Various prior art systems are employed to produce hydrogen, including electrolytic systems whereby a current is passed through an aqueous solution to force the separation of hydrogen and oxygen molecules from the water in the solution. Additionally, some prior art systems produce hydrogen by cracking various hydrocarbons to produce gaseous hydrogen. However, these hydrocarbon cracking systems require a large energy input to produce a relatively small amount of hydrogen gas, thereby making them considerably more expensive to produce than an equivalent energy amount of conventional gasoline.

[0005] In fact, none of these prior art systems are capable of producing hydrogen gas at a cost or volume necessary to make it a competitively priced fuel to gasoline. Additionally, one of the underlying purposes for hydrogen fuel cell production is to employ the fuel cells as the motive force of the modern automobile, thereby reducing atmospheric emissions caused by the combustion of conventional hydrocarbon fuels. However, since a great deal of energy is required to produce hydrogen by prior art methods, and this energy is primarily produced by burning coal or oil, the overall environmental impact of utilizing hydrogen as a fuel is not greatly reduced by modern hydrogen production methods.

[0006] Furthermore, the utilization of hydrogen gas as a direct injection additive to modern internal combustion engines greatly enhances the operating efficiency of the engines. However, it is difficult to store hydrogen gas on board an automobile or other conveyance, due to the necessity of high pressure storage tanks and the concomitant safety hazards entailed in storing a highly pressurized explosive gas in a vehicle.

[0007] The present invention obviates the aforementioned problems by providing an apparatus, system and method for hydrogen and oxygen gas production that is initiated via a controlled electrolytic reaction in a chamber wherein an aqueous fluid resides, resulting in separation of the aqueous fluid into its elemental components. Specifically, the present invention provides an apparatus and method for separation of elemental hydrogen and oxygen from an aqueous solution utilizing electrolytic action to initiate the separation process and a resultant pyrolitic reaction that greatly enhances separation of elemental hydrogen and oxygen from the aqueous solution.

[0008] The apparatus of the present invention includes an outer chamber containing the aqueous solution and enclosing a plurality of cathodes placed at a plurality of points around the interior the outer chamber. The invention further includes an inner chamber disposed inside the outer chamber and in fluid communication with the first chamber at a portion thereof. The second chamber partially encloses a single anode and includes a vent to permit gas produced during the reaction to escape from the second chamber.

[0009] The plurality of cathodes are placed at various locations in the first chamber such that they are substantially equidistant from the single anode. The cathodes and anode are thence electrically connected to a source of direct current power, whereby current flows from the anode through the aqueous solution to the plurality of cathodes, creating a plurality of current conduction paths through the fluid in the outer chamber. These conduction paths necessarily converge in an area of the second chamber proximate the anode, creating extremely high temperature and the release of concomitant light energy around the anode, thereby enhancing the gas separation reaction by sustaining a pyrolitic reaction proximate the anode.

[0010] Other features, objects and advantages of the present invention will become clear after reading the detailed description of the preferred embodiments taken in conjunction with the appended drawing Figures.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0011] FIG. **1** is a schematic view of an apparatus for fluid separation in accordance with one embodiment of the present invention.

[0012] FIG. **2** is a view of the apparatus of FIG. **1** taken along the line **2-2** in accordance with one embodiment of the present invention.

[0013] FIG. **3** is a schematic view of an apparatus for fluid separation employing spherical reaction chambers in accordance with one embodiment of the present invention.

[0014] FIG. **4** is a schematic view of an apparatus for fluid separation in accordance with an alternative embodiment of the invention utilizing Tesla coils in place of cathodes.

[0015] FIGS. **5**A-C are graphical representations of exemplary direct current waveforms in accordance with alternative embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0016] Referring now to drawing FIGS. **1-4**, and in accordance with a constructed embodiment of the present invention, an apparatus **10** for the separation of hydrogen and oxygen from an aqueous fluid comprises a first chamber **20**

that is capable of containing an aqueous solution or fluid **1** therein and that is substantially non-reactive with fluid **1**. For purposes of the description of the present invention reference will consistently be made to production of hydrogen and oxygen by separation of an aqueous solution caused by a controlled pyrolitic reaction initiated by electrolysis. One of ordinary skill in the art will recognize that the apparatus and method described and claimed herein may be employed to produce or liberate various constituents capable of being separated through electrolytic and pyrolitic reaction mechanisms.

[0017] The separation apparatus **10** further comprises an inner chamber **30** that is in fluid communication with outer chamber **20** at an open portion **32** thereof to permit aqueous solution **1** to enter inner chamber **30**. Furthermore, inner chamber **30** comprises a port or vent **34** to permit the gas created therein to exit inner chamber **30** to be collected in a tank **36** or similar receptacle. Similarly, outer chamber **20** may include a port or vent **24**, or a plurality thereof, to allow the gas created therein to exit outer chamber **20** thence be collected in a tank **26**, as will be discussed in greater detail herein below.

[0018] The invention **10** further comprises a plurality of cathodes **50** disposed at a plurality of points in outer chamber **20**. As seen in FIG. **1** cathodes **50** are disposed circumferentially around a wall **28** of outer chamber **20**. Cathodes **50** may be secured to the interior of wall **28** of outer chamber **20**, or alternatively positioned through a plurality of apertures **22** located at a plurality of points in wall **28** around outer chamber **20**.

[0019] A single anode **60** is located proximate the open portion **32** of inner chamber **30**. Anode **60** may be secured directly to inner chamber **30**, or it may be mounted through an aperture **22** in outer chamber **20** and extend inwardly into inner chamber **30**, as best seen in FIGS. **1** and **4**.

[0020] Anode **60** is advantageously positioned at a location within inner chamber **30** such that any gas produced proximate anode **60** will rise within inner chamber **30**, and not escape outwardly into outer chamber **20**. This feature of the present invention enhances the separation of the constituent gases so that the resultant hydrogen and oxygen gases drawn from the apparatus **10** are relatively pure. In a yet further embodiment of the invention, cathodes **50** may be arranged such that they are each substantially equidistant from a point in inner chamber **30**, as will be discussed in greater detail herein below.

[0021] Both outer chamber **20** and inner chamber **30** may be comprised of, for example, a plexiglass or polycarbonate material, or alternatively any variety of non-reactive materials capable of containing aqueous solution **1**. Inner chamber **30** and outer chamber **20** may also be comprised of a non-reactive metal such as stainless steel.

[0022] The present invention further comprises a power supply **3** capable of delivering direct current (DC) power to a load. The power supply **3** is connected between anode **60** and the plurality of cathodes **50** to create a potential difference therebetween. In one embodiment of the present invention, DC power supply **3** provides a square wave direct current signal at 240 volts as an input power source to the invention **10**. The utilization of a pulsed direct current wave form from power source **3** as provided by a square wave DC power generator permits enhanced electrolytic and pyrolitic reactions in an area proximate anode **60**, as will be described further herein below. In a yet further embodiment of the present invention, a conventional DC welding generator operating at, for example, 240 VDC may be employed as power source **3**.

[0023] The present invention may further comprise a plurality of conventional condensers or heat exchangers **80** that are positioned proximate ports **24** and **34** to remove any residual steam or moisture that may escape through ports **24** and **34**, thereby permitting the gasses exiting through ports **24** and **34** to enter tanks **26** and **36** respectively, relatively free of residual moisture.

[0024] A make up aqueous solution tank **90** may be used to maintain fluid **1** in outer chamber **20** at a relatively constant level and temperature through operation of an intake valve **92** and supply line **94**. If desired, a simple feedback control system utilizing commercially available level and temperature sensors may be employed to maintain a relatively constant fluid level and fluid temperature in outer and inner chambers **20** and **30** respectively by simple activation of a solenoid operated valve **92** responsive to level and temperature measurements. The level of aqueous solution **1** in outer chamber **20** should remain above the points at which cathodes **50** are located to enable an efficient conduction of current from cathodes **50** to anode **60** once power source **3** is connected therebetween.

[0025] While the electrically conductive cathodes **50** and anode **60** may comprise a wide variety of materials, one of ordinary skill will appreciate that non-reactive conductive materials will provide the longest service life before replacement becomes necessary. Materials that may be used as anode **60** include, but are not limited to gold, silver, platinum, carbon and chrome-moly. Materials suitable for use as cathodes **50** include, but are not limited to titanium, carbon, zinc, stainless steel and aluminum.

[0026] In one embodiment of the present invention anode **60** further comprises an insulating portion **62** secured around anode **60** that extends into open portion **32** of inner chamber **30**, as best seen in FIG. **1**. Insulating portion **62** covers that portion of anode **60** that is exposed in outer chamber **20** thereby prohibiting it from conducting electricity so that all conduction takes place at a top exposed portion **64** of anode **60**, which is located in inner chamber **30**. This feature of the present invention forces the current conduction paths from cathodes **50** to anode **60** to extend upwardly into inner chamber **30** and converge at a point proximate the top portion **64** of anode **60**, thereby creating an electrolytic and pyrolitic reaction that liberates hydrogen and oxygen from aqueous solution **1** proximate anode **60**. The liberated hydrogen gas thence bubbles upwardly from anode **50** through inner chamber **30**, through port **34** and into tank **36**.

[0027] Simultaneously, a concomitant release of oxygen gas occurs at cathodes **50** due to electrolysis of aqueous solution **1**, whereupon the oxygen exits outer chamber **20** at port **24** and is stored in tank **26**. The area immediately surrounding exposed portion **64** of anode **60** becomes extremely hot, thereby initiating pyrolitic separation of the fluid **1** molecules proximate anode **60** which results in tremendous efficiency of separation of fluid **1** into its constituent gases.

[0028] Drawing FIG. **3** depicts an alternative embodiment of the present invention wherein inner and outer chambers

30 and 20 are substantially spherical in shape, and wherein inner spherical chamber 30 remains in fluid communication with outer chamber 20 via an open portion 32. Cathodes 50 are spaced around an interior surface 28 of outer chamber 20, or at a plurality of points that are substantially equidistant to anode 60, disposed within inner chamber 20. In fact, a wide variety of container shapes may be employed for outer chamber 20 and inner chamber 30, as long as a plurality of cathodes 50 are spaced such that they are substantially equidistant from anode 60, so that the electrical resistance between each of the plurality of cathodes 50 and anode 60 is approximately equal. This arrangement permits the near simultaneous convergence of a plurality of current conduction paths at anode 60, whereby the gas-liberating reaction is initiated. In an alternative embodiment of the instant invention, the plurality of cathodes 50 may be arranged so that their respective distances to anode 60 are not substantially equidistant.

[0029] In a yet further embodiment of the invention 10 as shown in FIG. 4, a plurality of Tesla coils 100 are employed in place of cathodes 50, and a single ground rod or terminal 110 replaces anode 60 so that a plurality of electrical discharges occur between each of said plurality of Tesla coils and ground rod 110, thereby initiating a pyrolitic reaction resulting in the liberation of hydrogen and oxygen gasses from aqueous solution 1. Tesla coils 100 are powered by conventional electronic circuitry, available from, for example, Lindsay Scientific Co., Inc.

[0030] Alternatively, Tesla coils 100 may be electrically connected to a plurality of cathodes 50 that are already positioned in outer chamber 20 such that the cathodes 50 conduct the electrical energy discharged from Tesla coils 100. Ground terminal 110 may still include an insulating portion 62 separating ground terminal 110 from outer chamber 20. This feature of the invention forces the electrical discharge from Tesla coils 100 to travel downwardly in outer chamber 20, thence upwardly into inner chamber 30 to find a conduction path to ground through terminal 110, thereby concentrating the liquid separation reaction proximate the tip of terminal 110.

[0031] In operation, power source 3 is electrically connected between cathodes 50 and anode 60 whereby an electrical current conduction path is established through aqueous solution 1 between each cathode 50 and anode 60. These multiple current conduction paths converge proximate the conductive portion of anode 60 resulting in both an electrolytic reaction and pyrolitic reaction that occurs around anode 60. The initial electrolytic reaction begins liberation of constituent gases through conventional electrolysis. The convergence of the multiple conductive paths proximate anode 60 cause extremely high temperatures in a reaction space proximate anode 60, thereby initiating a pyrolitic reaction in the reaction space. In an alternative embodiment of the present invention, a square wave output DC generator may be used as power source 3 operating at, for example, 240 VDC. By slight variations and control of the current supplied by power source 3 the pyrolitic reaction may be controlled and sustained in a stable fashion.

[0032] As seen if FIGS. 5A-C, the DC power source 3 may provide a pulsed DC output signal as an input voltage between cathodes 50 and anode 60. FIG. 5A depicts a half-wave rectified AC input, FIG. 5B depicts a constant voltage pulsed DC input, and FIG. 5C depicts a saw tooth DC input, any of which may be advantageously employed as a DC power source for the instant invention to initiate and sustain the gas liberating reactions. While FIGS. 5A-5C depict exemplary power input waveforms, they are not intended to be limiting to the scope of the present invention which is capable of being operated in conjunction with a wide variety of power sources.

[0033] In an alternative embodiment of the invention, Tesla coils 100 are arranged to periodically discharge, either directly into outer chamber 20 or through cathodes 50, wherein the discharge results in electrical energy traveling through aqueous solution 1 to ground terminal 110, thereby resulting in electrolytic separation as well as pyrolitic separation of hydrogen and oxygen.

[0034] In a further embodiment of the present invention a wide variety of chemical catalysts may be added to aqueous solution 1 to enhance the electrolytic and pyrolytic reactions at anode 60 thereby resulting in more efficient separation of hydrogen and oxygen. For example, muratic acid solutions, hydrochloric acid solutions, sulfuric acid solutions, phosphoric acid solutions and potassium carbonate may all be added to aqueous liquid 1 to enhance the gas production process. Furthermore, these catalysts may be mixed with the aqueous solution 1 in make up tank 90 to provide a constant supply of aqueous solution 1 and catalyst to the system of the present invention through periodic actuation of valve 90

[0035] While the present invention has been shown and described herein in what are considered to be the preferred embodiments thereof, illustrating the results and advantages over the prior art obtained through the present invention, the invention is not limited to those specific embodiments. Thus, the forms of the invention shown and described herein are to be taken as illustrative only and other embodiments may be selected without departing from the scope of the present invention, as set forth in the claims appended hereto.

We claim:

1. An apparatus for producing hydrogen and oxygen gas from an aqueous liquid utilizing a direct current power source comprising:

an outer chamber containing said aqueous liquid;

an inner chamber disposed within said outer chamber and in fluid communication therewith;

a plurality of cathodes positioned in said outer chamber at a plurality of points;

a single anode positioned within said inner chamber; and

wherein said direct current power source is electrically connected between said plurality of cathodes and said anode thereby initiating an electrolytic reaction within said inner chamber causing hydrogen gas and oxygen gas production.

2. An apparatus as claimed in claim 1 wherein said plurality of cathodes are substantially equidistant from said anode.

3. An apparatus as claimed in claim 1 further comprising:

an outlet port in said inner chamber whereby the hydrogen produced therein may be vented.

4. An apparatus as claimed in claim 3 wherein said inner and outer chambers are substantially cylindrical.

5. An apparatus as claimed in claim 4 wherein the cylindrical inner chamber comprises an open end in fluid communication with said outer chamber and wherein said anode is positioned proximate the open end such that hydrogen gas produced proximate said anode rises through said cylindrical inner chamber and exits through the outlet port therein.

6. An apparatus as claimed in claim 1 wherein said inner and outer chambers are substantially spherical.

7. An apparatus as claimed in claim 3 further comprising an outlet port in said outer chamber whereby oxygen produced therein may be vented.

8. An apparatus as claimed in claim 1 further comprising:

a condenser in fluid communication with an upper portion of said inner chamber for removing residual moisture from the hydrogen gas produced therein.

9. An apparatus as claimed in claim 7 further comprising:

a condenser in fluid communication with an upper portion of said outer chamber for removing residual moisture from the oxygen gas produced therein.

10. An apparatus as claimed in claim 1 wherein said direct current power source supplies a pulsed direct current output to said apparatus.

11. An apparatus as claimed in claim 10 wherein said pulsed direct current output comprises a square wave output.

12. An apparatus as claimed in claim 10 wherein said pulsed direct current output comprises a saw tooth wave output.

13. An apparatus as claimed in claim 10 wherein said pulsed direct current output is half-wave rectified alternating current.

14. A method for producing hydrogen from an aqueous liquid utilizing a direct current power source comprising the steps of:

providing an outer chamber for containing said aqueous liquid;

providing an inner chamber disposed within said outer chamber and in fluid communication therewith;

providing a plurality of cathodes disposed at a plurality of points within said outer chamber;

providing an anode disposed within said inner chamber; and

connecting said direct current power source between said anode and said plurality of cathodes whereby direct current flows from said cathodes to said anode, thereby initiating a reaction proximate said anode, a product of which is hydrogen.

15. A method as claimed in claim 14 wherein said direct current power source supplies a pulsed direct current output to said apparatus.

16. A method as claimed in claim 15 wherein said pulsed direct current output comprises a square wave output.

17. A method as claimed in claim 15 wherein said pulsed direct current output comprises a saw tooth wave output.

18. A method as claimed in claim 15 wherein said pulsed direct current output is half-wave rectified alternating current.

19. A method for producing hydrogen from an aqueous liquid as claimed in claim 14 wherein said reaction proximate said anode is an electrolytic reaction.

20. A method for producing hydrogen from an aqueous liquid as claimed in claim 19 wherein said reaction proximate said anode further comprises a pyrolitic reaction.

21. An apparatus for producing hydrogen gas and oxygen gas from an aqueous liquid utilizing a high voltage electrical discharge power source comprising:

an outer chamber containing said aqueous liquid;

an inner chamber disposed within said outer chamber and in fluid communication therewith;

a plurality of Tesla coils positioned in said outer chamber at a plurality of points;

a single ground terminal positioned within said inner chamber; and

wherein said power source is electrically connected to said plurality of Tesla coils thereby initiating a periodic electrical discharge from said coils to said ground terminal causing an electrolytic reaction within said inner chamber that liberates hydrogen gas and oxygen gas from said aqueous liquid.

22. An apparatus for producing hydrogen and oxygen from an aqueous liquid as claimed in claim 21 wherein said outer chamber and said inner chamber are cylindrical.

23. An apparatus for producing hydrogen and oxygen from an aqueous liquid as claimed in claim 22 wherein said outer chamber and said inner chamber are spherical.

* * * * *